Function generator 0.1Hz-2MHz

PM 5132

9445 051 32001

Instruction manual – Gerätehandbuch – Mode d'emploi et d'entretien

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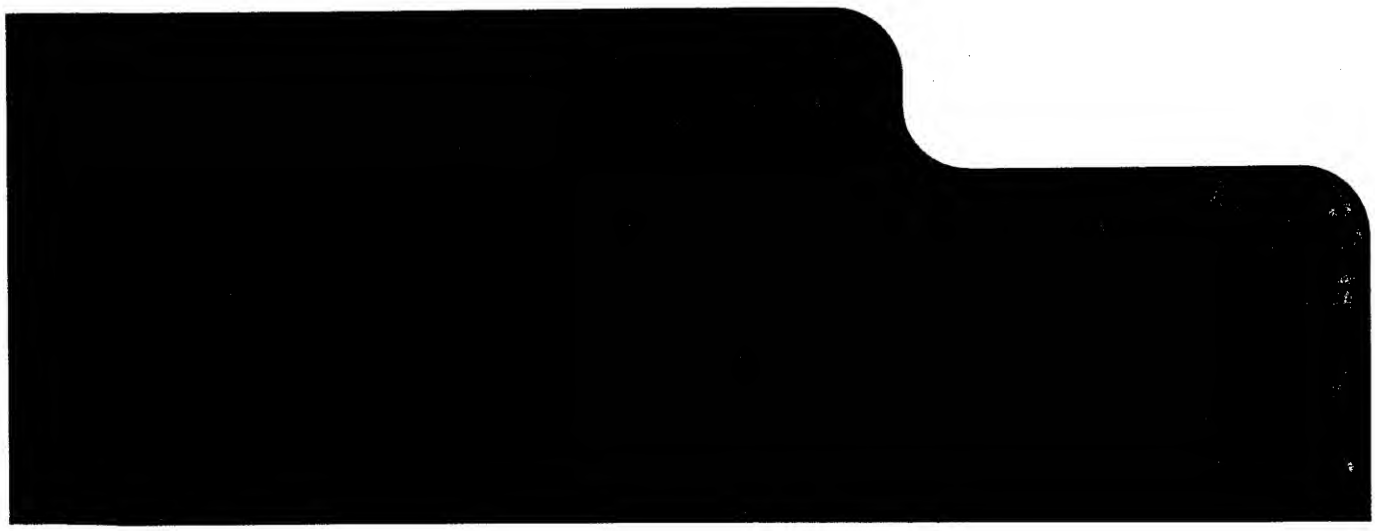

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Please note

In correspondence concerning this instrument, please quote the type number and serial number as given on the type plate.

Bitte beachten

Bei Schriftwechsel über dieses Gerät wird gebeten, die Typennummer und die Gerätenummer anzugeben. Diese befinden sich auf dem Typenschild an der Rückseite des Gerätes.

Noter s. v. p.

Dans votre correspondance et dans vos réclamations se rapportant à cet appareil, veuillez toujours indiquer le numéro de type et le numéro de série qui sont marqués sur la plaquette de caractéristiques.

Important

As the instrument is an electrical apparatus, it may be operated only by trained personnel. Maintenance and repairs may also be carried out only by qualified personnel.

Wichtig

Da das Gerät ein elektrisches Betriebsmittel ist, darf die Bedienung nur durch eingewiesenes Personal erfolgen. Wartung und Reparatur dürfen nur von geschultem, fach- und sachkundigem Personal durchgeführt werden.

Important

Comme l'instrument est un équipement électrique, le service doit être assuré par du personnel qualifié. De même, l'entretien et les réparations sont à confier aux personnes suffisamment qualifiées.

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1. GENERAL

1.1. INTRODUCTION

The PM 5132 function generator is an instrument designed for applications extending from the educational to the general purpose area.

It produces sinewave, triangular and squarewave output signals as well as positive and negative pulses, the frequencies of which are adjustable in seven linear sub-ranges from 0.1 Hz to 2 MHz. The frequency vernier allows the frequency setting to be varied from −5 % to +5 %.

The output voltage is continuously adjustable from 3 Vpp to 30 Vpp and can be attenuated in steps of 10 dB to 60 dB.

A continuously adjustable d.c. output voltage can be selected separately or whenever used as d.c. offset voltage added to the selected output signal.

The internal resistance of the generator can be selected by means of a pushbutton between 50 Ω and 600 Ω.

The duty cycle can be set to a fixed value of 50 % or is continuously adjustable between 10 % and 90 %.

The generator frequency is controllable in each of the seven sub-ranges (internal sweep). The sweep period is adjustable within a range of 0.05 s to 100 s. Moreover external sweep and frequency modulation can be performed.

For TTL applications a separate output is available.

The ergonomic design of controls and sockets serves for convenient operating of the instrument.

1.2. TECHNICAL DATA

Safety characteristics
This apparatus has been designed and tested in accordance with Safety Class I requirements of IEC Publication 348, Safety Requirements for Electronic Measuring Apparatus, and has been supplied in a safe condition. This manual contains some information and warnings which must be followed by the user to ensure safe operation and to retain the apparatus in a safe condition.

Performance characteristics, specifications
Properties expressed in numerical values with stated tolerance are guaranteed by the manufacturer. Specified non-tolerance numerical values indicate those that could be nominally expected from the mean of a range of identical instruments.
This specification is valid after the instrument has warmed up for 30 minutes (reference temperature 23 °C).
If not stated otherwise, relative or absolute tolerances relate to the set value.

1.2.1. Frequency

Frequency range		0.1 Hz - 2 MHz
Selected range	I	0.1 Hz - 2 Hz
	II	1 Hz - 20 Hz
	III	10 Hz - 200 Hz
	IV	100 Hz - 2 kHz
	V	1 kHz - 20 kHz
	VI	10 kHz - 200 kHz
	VII	100 kHz - 2 MHz

Characteristic	linear
Adjustments	– seven range-pushbuttons – dial with linear scale – knob for fine-adjustment
Frequency indication	– linear scale on the dial
Setting error	±2 % of dial setting ±0,2 % of full scale
Vernier frequency adjustment	±5 % of the dial setting
Temperature coefficient	<0,1 %/K ranges II - VI <0,15 %/K ranges I - VII
Short term drift	< 0.10 % ranges I - VI < 0.50 % range VII } within 15 min
Long term drift	< 0.25 % ranges I - VI < 1.50 % range VII } within 7 hours

1.2.2. Signal output

Connection	BNC socket
Impedance	50 Ω/600 Ω, selected by pushbutton
Load capability	short-circuit proof
Wave forms	∼ sinewave ⩘ triangular wave ⊓⊔ squarewave ⊓— positive pulse ⊔— negative pulse DC d.c. voltage without a.c.
Duty cycle	adjustable from 10 % to 90 % when pushbutton DUTY CYCLE is pressed (restricted use in range VII)
Open-circuit voltage	
– setting range	3 Vpp to 30 Vpp, continuously adjustable 1,5 Vpp to 15 Vpp for pulses
–maximum value	±15 V
DC (offset) voltage	
– button PUSH FOR ZERO pulled, open circuit voltage	-10 to +10 V, continuously adjustable
– button PUSH FOR ZERO or WAVE FORM button DC pressed	< 50 mV
Attenuation	
– continuous	0 to 20 dB (output voltage adjustable from 3 Vpp to 30 Vpp)
– fixed	0 to 60 dB in steps of 10 dB
Distortion (sinewave)	< 0,5 % in ranges I to V < 1 % in range VI < 3 % in range VII
Linearity (triangular wave)	> 99 %

risetime, falltime (squarewave)	< 75 ns (at max. amplitude, load 50 Ω)
overshoot and ringing (squarewave)	< 2 % (at max. amplitude, load 50 Ω)
Amplitude response (sinewave, reference value = 1 k Hz;)	< 0.1 dB in ranges I to V < 0.3 dB up to 1 MHz < 1 dB in ranges I to VII (at max. amplitude, load 50 Ω, attenuation 0 dB).

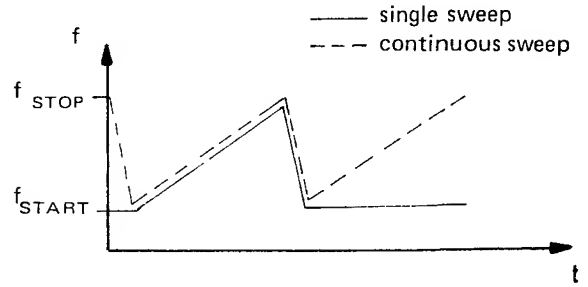
1.2.3. TTL-output

Connection	BNC socket at the rear side
Duty cycle, frequency	identical with main output
Fan out	20 TTL inputs

1.2.4. Frequency control

1.2.4.1. Internal sweep

Sweep modes	– single sweep started by a pulse (SWEEP TRIG INPUT) – single sweep started by pressing the pushbutton TRIG – continuous sweep



Sweep characteristic	linear
Start frequency	continuously adjustable within the respective frequency range after the pushbutton STD BY / CONT is set to STD BY.
Stop frequency	identical to the dial adjustment
Sweep period	50 ms to 100 s, adjustable in three ranges: – 50 ms to 1 s – 0,5 s to 10 s – 5 s to 100 s
Sweep control elements	– pushbutton to start a single sweep – pushbutton to stop the running sweep immediately – pushbutton for resetting to f_{START} during single sweep.

SWEEP TRIG INPUT

– Connection	BNC socket at the rear side
– Impedance	$> 10\ k\Omega$
– Max. input voltage	±15 V
– Release criterion	negative going edge of a pulse (from High to Low); e.g. TTL signal with slew rate > 0.5 V/ms

SWEEP VOLTAGE OUTPUT

– Connection	BNC socket at the rear side
– Impedance	$10\ k\Omega$
– Output voltage	0 V to 5 V ($f_{START} \cdots f_{STOP}$)

PEN LIFT

– Connection	BNC socket at the rear side electronic switch, open during flyback, closed during the sweep. max. current: 200 mA ┐ electronic switch output voltage: < 0,7 V ┘ closed output voltage: +22 V ┐ electronic switch internal resistance: 100 kΩ ┘ open

1.2.4.2. External sweep or frequency modulation (SWEEP INPUT)

– Connection	BNC socket
– Voltage vs. frequency characteristic	linear
– Impedance	$47\ k\Omega$
– Max. sweep range	2 1/2 decades
– Max. sweep frequency	15 kHz
– Sensitivity	1 V / 0,2 $f_{max.}$ where f_{max} represents the upper limit of the corresponding subrange.

1.2.5. Power supply AC mains

– Reference value	220 V
– Nominal vaues	110 V / 128 V / 220 V / 238 V, selectable by solder links
– Nominal operating range	±10 % of selected nominal value
– Operating limits	±10 % of selected nominal value
– frequency range of operation	47,5 – 105 Hz
– Power consumption	25 W

1.2.6. Environmental conditions

Ambient temperature	
– Reference value	+23° C ±1° C
– Nominal operating range	+ 5° C to +40° C
– Limits for storage and transportation	-40° C to +70° C
Relative humidity	
– Reference range	45 % to 75 %
– Nominal operating range	20 % to 80 %
– Limits for storage and transportation	0 % to 90 %
Air pressure	
– Reference value	1013 mbar (= 760 mmHg)
– Nominal working range	800 - 1066 mbar (up to 2200 m height)
Air speed	
– Reference value	0 to 0,2 m/s
– Nominal working range	0 to 0,5 m/s
Operating position	normally upright on feet or with handle fold down
Warm-up time	30 min.

1.2.7. Cabinet

Protection type (see DIN 40 050)	IP 20
Protection class (see IEC 348)	class I, protective conductor
Overall dimensions	
– height	140 mm
– width	310 mm
– depth	330 mm
Weight	approx. 5 kg

1.3. ACCESSORIES

1.3.1. Standard

Instruction manual,
fuse and voltage labels

1.3.2. Optional

PM 9585: 50 Ω termination 1 W
PM 9581: 50 Ω termination 3 W
PM 9075: Coaxial connection cable BNC—BNC

1.4. OPERATING PRINCIPLE (see Fig. 1., block diagram)

The main oscillator of the function generator comprises the switched integrator and the peak detector (comparator). The controlled current source of the d.c. control section generates the charging current for the integrator. At the integrator output a linear voltage ramp is fed to the peak detector. When reaching the reference voltage the detector reverses the charging current of the integrator resulting in integration in the opposite direction.
Integration down is performed until reaching the negative reference level of the peak detector, which again reverses the current of the switched integrator. As both reference levels are symmetrical with respect to earth, a zero symmetrical triangular wave is generated at the output of the integrator. The duty cycle of this wave is 1 : 1 and can be adjusted continuously between 1 : 9 and 9 : 1 when push-button DUTY CYCLE is pressed.

The output current of the controlled current source depends on the positions of the frequency dial and the FREQUENCY OFFSET control. The resulting frequency of the oscillator is determined by this current and -in addition- by the integrating capacitor in the switched integrator. Different capacitors are switched in by the FREQUENCY Hz pushbuttons.

External sweep and frequency modulation can be performed via the SWEEP INPUT socket. The voltage to frequency relationship is linear.

Internal frequency control is effected by the sweep oscillator, a continous sweep is started by setting the pushbutton STD BY/CONT to position CONT. Starting a single sweep can be done by pressing the pushbutton TRIG. Moreover it is possible to start a single sweep by means of an external trigger pulse connected to the SWEEP TRIG INPUT socket.

The sweep range is adjustable by means of the knob START FREQ and the dial which represents the stop frequency. They are adjustable independantly; the start frequency may be set greater or less than the stop frequency.

Moreover the outputs PEN LIFT and SWEEPOUTare controlled by the sweep oscillator. The PEN LIFT socket represents the output of an electronic switch being closed during the sweep. The SWEEP OUT socket gives the instantaneous sweep voltage corresponding to a distinct frequency of the oscillator: 0 V = start frequency, +5 V = stop frequency f_{STOP} . The voltage to frequency relationship is linear.

The WAVE FORM switch allows the following wave forms to be selected: a triangular wave from the integrator, a sine wave formed by the sine shaper circuitry from the triangular wave, a square wave, negative and positive pulses from the peak detector.

The selected signal is fed to the OUTPUT socket via amplifier and attenuator. The internal resistance can be switched to 600 Ω or to 50 Ω.

By means of the DC OFFSET control a d.c. voltage can be added to the signal, activated by pulling the PUSH FOR ZERO switch/turn-knob. If d.c. voltage only is requested, the a.c. part of the output signal can be switched off by pressing the DC pushbutton of the wave form selector.

A squarewave signal of the peak detector is fed to the socket TTL OUT via the TTL buffer.
The stabilized power supply provides the d.c. voltages for the circuitries.

2. INSTALLATION INSTRUCTIONS

2.1. INITIAL INSPECTION

Check the contents of the shipment for completeness and note whether any damage has occurred during transport. If the contents are incomplete, or there is damage, a claim should be filed with the carrier immediately, and the Philips Sales or Service organisation should be notified in order to facilitate the repair or replacement of the instrument.

2.2. SAFETY INSTRUCTIONS

Upon delivery from the factory the instrument complies with the required safety regulations, see para. 1.2. To maintain this condition and to ensure safe operation, the instructions below must carefully be followed.

2.2.1. Maintenance and repair

Failure and excessive stress:
If the instrument is suspected of being unsafe, take it out of operation permanently.
This is the case when the instrument
- shows physical damage
- does not function anymore
- is stressed beyond the tolerable limits (e.g. during storage and transportation)

Dismantling the instrument: When removing covers or other parts by means of tools, live parts or terminals could be exposed. Before opening the instrument, disconnect it from all power sources.

If the **open live instrument needs calibration, maintenance or repair,** it must be performed only by trained personnel being aware of the risks. After disconnection from all power sources, the capacitors in the instrument may remain charged for some seconds.

2.2.2. Earthing (grounding)

Before any other connection is made the instrument shall be connected to a protective earth conductor via the three-core mains cable. The mains plug shall be inserted only into a socket outlet provided with a protective earth contact. The protective action shall not be negated by the use of an extension cord without protective conductor.
The external contacts of the BNC sockets must not be used to connect a protective conductor.

WARNING:	Any interruption of the protective conductor inside or outside the instrument, or disconnection of the protective earth terminal, is likely to make the instrument dangerous. Intentional interruption is prohibited.

The circuit earth potential applied to the external contacts of the BNC sockets is connected to the cabinet. The external contacts of the BNC sockets must not be used to connect a protective conductor.

2.2.3. Connections

The circuit earth potential is applied to the external contacts of the BNC sockets and is connected to the cabinet by means of parallel-connected capacitor and resistor. By this means hum loops are avoided and a clear HF earthing is obtained.
If the circuit earth potential in a measurement set-up is different from the protective earth potential, it must be noticed,
- that the BNC sockets can be touched and that it must not be live, see the safety regulations on the subject (VDE 0411),
- that all sockets marked with the sign ⊥ are internally interconnected.

2.2.4. Mains voltage setting and fuses

Before inserting the mains plug into the mains socket, make sure that the instrument is set to the local mains voltage.
The instrument shall be set to the local mains voltage only by a qualified person who is aware of the hazard involved.

WARNING:	If the mains plug has to be adapted to the local situation, such adaption should be done by a qualified person only.

Make sure that only fuses of the required current rating, and of the specified type, are used for renewal. The use of repaired fuses, and/or the short-circuiting of fuse holders, are prohibited.
The fuse shall be renewed only by a qualified person who is aware of the hazard involved.

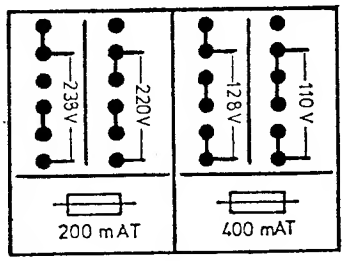
WARNING:	The instrument shall be disconnected from all voltage sources when a fuse is to be renewed, or when the instrument is to be adapted to a different mains voltage.

2.3. MAINS VOLTAGE SETTING AND FUSES

The safety instructions in chapter 2.2.4. must be followed.

On delivery from the factory the instrument is set to 220 V (PM 5132) resp. 110 V (PM 5132 M).
If the instrument is to be used on a different supply voltage proceed as follows:

- Unplug the mains connector
- Fold up the handle to the top.
  For this push the buttons of the handle.
- Loosen the central screw at the rear
- Dismantle the cabinet
- Change the solder links
  according to the connection diagram



- If necessary exchange the supplied fuse and mains voltage label
- Close the instrument

2.4. OPERATING POSITION OF THE INSTRUMENT

The instrument may be used in the positions indicated in clause1.2. 6.With the handle folded down, the instrument may be used in a sloping position; for this push the buttons of the handle. The characteristics mentioned in Section 1.2. are guaranteed for the specified positions.
Ensure that the ventilation holes in the cover are free of obstruction.
Do not position the instrument on any surface which produces or radiates heat, or in direct sunlight.

2.5. DISMANTLING THE INSTRUMENT

- Unplug the mains connector
- Fold up the handle to the top. For this push the buttons of the handle
- Loosen the central screw at the rear
- Dismantle the cabinet

2.6. RADIO INTERFERENCE SUPPRESSION

Radio interference of the instrument is suppressed and checked carefully. In connection with deficient suppressed base units and further units radio interference can be generated, which have to be suppressed by means of additional activities.

3. OPERATING INSTRUCTIONS

3.1. CONTROLS AND SOCKETS (FIG. 2, 3)

Legend	Position	Function
POWER ○ ON ● OFF	251	mains switch; white dot for ON position
WAVE FORM ∿ ∿ ⊓ ⊓ ⊔ DC	253/9 to 253/4	pushbuttons for the required waveform: sinewave, triangular-, square-wave, positive or negative pulses, DC without ac portion
FREQUENCY Hz x.1 x1 x10 x100 x1K x10K x100K	253/16 to 253/10	pushbuttons for selecting the frequency range 0,1 - 2 Hz, 1 Hz - 20 Hz, 10 Hz - 200 Hz, 100 Hz - 2 k Hz, 1 kHz - 20 k Hz, 10 k Hz - 200 k Hz, 100 k Hz - 2 MHz
1 . . . 20 (Linear scale)	648	dial for continuous coarse frequency adjustment
FREQ OFFSET	647	knob for continuous fine frequency adjustment
DUTY CYCLE	252/5	pushbutton to switch on the duty cycle adjustment
DUTY CYCLE	673	knob for duty cycle adjustment
ATTENUATION 10 dB 20 dB 30 dB	253/3 to 253/1	pushbuttons for setting the fixed attenuation; 40 dB to 60 dB by combination of pushbuttons
AMPLITUDE 3 Vpp to 30 Vpp	821	knob for continuous amplitude adjustment of the output signal.
DC OFFSET −10 V to +10 V	822	knob for continuous d.c. voltage adjustment
PUSH FOR ZERO	822	pull-switch for switching in the d.c. voltage
OUTPUT	875	BNC socket for the output signal
TTL OUT	874	BNC socket for TTL output signal (at the rear side)
600 Ω/50 Ω		pushbutton for selecting the impedance of the main output.
PEN LIFT	872	control signal for pen writing in case of plotting (BNC socket at the rear side).
SWEEP INPUT	873	BNC socket at the rear side; input of external sweep voltage
SWEEP OUT	871	BNC socket at the rear side; output of the sweep voltage during internal sweep
START FREQ CHECK IN STD BY	646	knob for adjusting the start-frequency

TRIG	252/4	pushbutton for starting a single sweep
STD BY	252/3	STD BY - for adjusting the start frequency and for single sweep
CONT		CONT - continuous sweep
SWEEP PERIOD s	256	range selector for the sweep period
PERIOD	601	knob for adjusting the sweep period
HOLD	252/1	pushbutton for stopping the sweep immediately
RESET	252/2	pushbutton for resetting during single sweep to f_{START}.
SWEEP TRIG INPUT	870	BNC socket at the rear side – to start a sweep by means of an external signal.

3.2. OPERATION

3.2.1. Setting the voltage at socket OUTPUT

By means of the control AMPLITUDE, the amplitude of the output signal is continuously variable. Released button DC and pulled button PUSH FOR ZERO enables a continuously adjustable positive or negative d.c. voltage to be added to the output signal.
When pressing the button DC, the a.c. part of the output signal is switched off and the d.c. voltage only is fed to the output.
With step attenuator ATTENUATION, the output signal and the DC offset can be attenuated in steps of 10 dB up to 60 dB. For 10 dB to 30 dB separate pushbuttons are available. Attenuations of 40 and 50 dB are selected by combined pushbutton actions.
For 60 dB all three buttons have to be pressed.
By means of the pushbutton 600 Ω/50 Ω the internal resistance can be switched to 600 Ω or 50 Ω.

Note: The output amplifier could be overdriven due to adding signal and DC offset voltage. To avoid limiting, the peak value of the open-circuit output voltage must not exceed ±15 V (step attenuator set to 0 dB).

3.2.2. Setting the frequency

The PM 5132 offers three control elements for setting the frequency:

– a range selector FREQUENCY Hz with seven ranges
– a dial with linear scale
– vernier FREQ OFFSET control

The output frequency is represented by the scale reading multiplied by the factor of the range selector FREQUENCY Hz. In addition the frequency deviation set of the FREQ OFFSET control must be accounted for.

3.2.3. Setting the wave form

The required wave form is selected by pressing the according pushbutton of the wave form selector. If the duty cycle shall be set to any value different to 50 %, the pushbutton DUTY CYCLE must be pressed fo adjusting the duty cycle within 10 % and 90 % by means of the knob DUTY CYCLE.

At the TTL OUT socket a TTL signal is available, the frequency and duty cycle of which correspond to the signal at the OUTPUT socket.

3.2.4. Setting the internal sweep

The internal sweep action of the PM 5132 can be performed within one subrange.
The value of the dial represents the stop frequency, the start frequency is set according to the following rules:

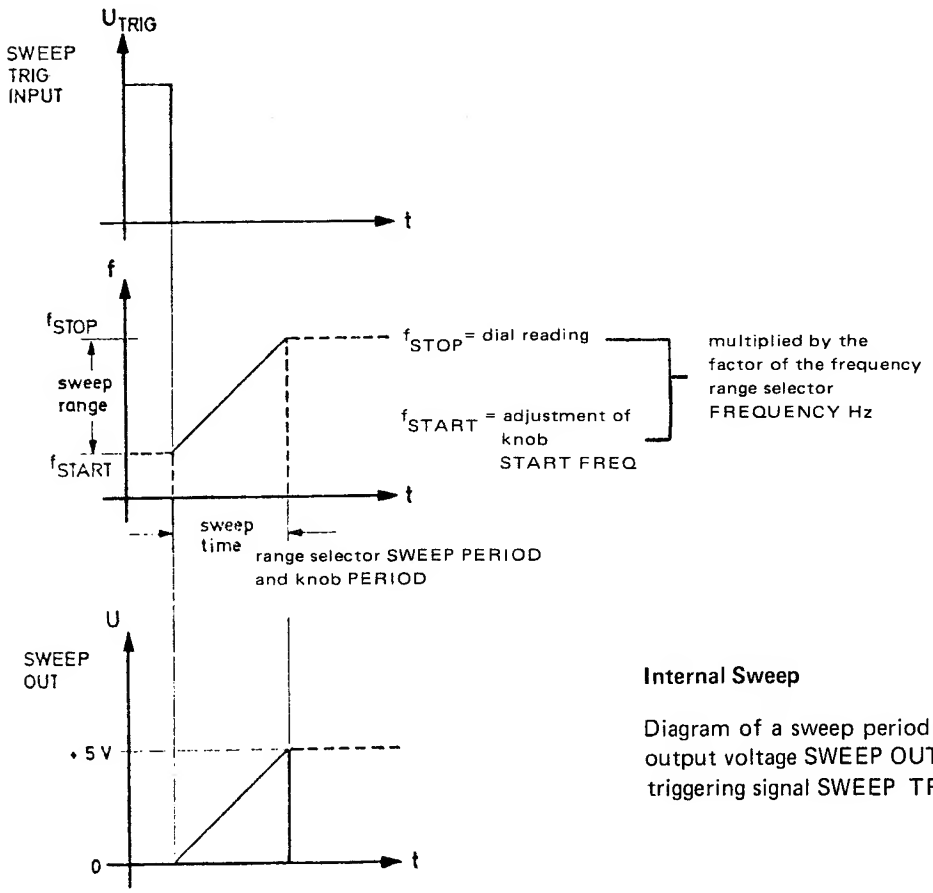
- pushbutton STD BY / CONT must be set to STD BY
- range selector SWEEP PERIOD s must be switched from OFF to the required range
- adjust the sweep period with the knob PERIOD
- adjust the start frequency with knob START FREQ. This frequency can now be measured at the socket OUTPUT.

The start frequency may be set greater or less than the stop frequency, a sweep can be performed in both directions , up and down.
Starting a single sweep is done by pressing the pushbutton TRIG once,the continuous sweep is realized by setting the pushbutton STD BY/CONT to CONT.
In position STD BY a single sweep can be started by a triggering pulse at the SWEEP TRIG INPUT socket. Starting criterion is a negative going edge e.g. of a TTL signal.

The SWEEP OUT socket at the rear side provides the instantaneous sweep voltage corresponding to a distinct signal frequency for controlling an oscilloscope or x - y plotter. The voltage to frequency relationship is linear, a sweep-voltage of 0 V represents f_{START}, a sweep voltage of +5 V f_{STOP}.

Further control elements for manual controlling are the HOLD pushbutton to stop the sweep immediately and RESET for resetting to f_{START} during single sweep.

Note: Before executing an internal sweep, disconnect all cables from the SWEEP INPUT socket. This input is not switched off during an internal sweep.

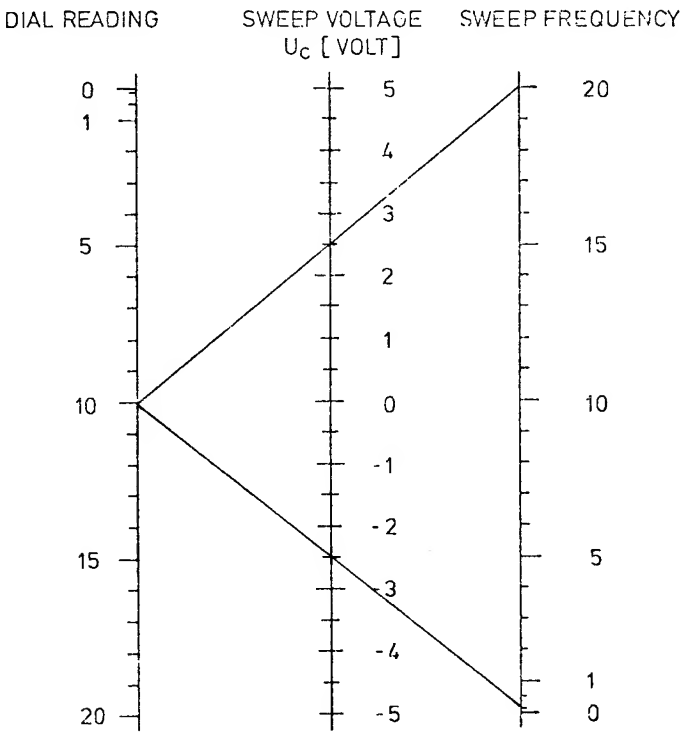


Internal Sweep

Diagram of a sweep period with the sweep output voltage SWEEP OUT and the triggering signal SWEEP TRIG INPUT.

3.2.5. External sweep and frequency modulation

The signal frequency of the generator can be controlled by connecting an external voltage to SWEEP INPUT. In order to avoid superpositions by the internal sweeps, switch the range selector SWEEP PERIOD s to OFF. The desired signal frequency (= basic frequency) must then be adjusted by means of the dial and the range selector FREQENCY Hz. By feeding a dc or ac voltage to the sweep oscillator via SWEEP INPUT, the signal frequency is varied proportional to this voltage (the relationship between voltage and frequency is linear). The maximum variation should not exceed 2 1/2 decades, where the upper limit of the sub-range is the upper limit for the sweep range too. Otherwise you would get signal distortions because of overdriving the controlled current source.



External sweep

Sweep range depending on the sweep voltage Uc. Example for subrange V (1 KHz - 20 KHz)

Service part

4.1. CIRCUIT DESCRIPTION PM 5132

4.1.1. Sweep oscillator

In sweep mode the sweep oscillator generates sawtooth voltage of 10 Vpp to control the main oscillator. The sweep oscillator mainly consists of the integrating operational amplifier 401 with charging capacitor 501 to 504, comparator 402 and regulator 301/302. The potmeter PERIOD 601 determines the charging current which is fed via resistor 616 and SK 252/1a to the integrator.

In sweep mode a positive voltage is applied to the input of the integrator, resulting in a slowly falling ramp at its output. The reference level of the comparator is set to 0 V and transistor 301 is turned off. As soon as the integrator voltage has reached this value the comparator turns over. So during fly-back the output voltage of the comparator is fed via conducting diode 421, resistor 615 and additionally via potmeter PERIOD and resistor 616 to the input of the integrator. So the integration capacitor is quickly discharged. When the integrator voltage has reached +10 V the comparator turns over and a new cycle starts.

In STAND BY mode the cycle just mentioned is interrupted after fly-back. The positive reference level of the comparator 402 is set to +11 V by opening the parallel path SK 252/3a and resistor 622. So the comparator cannot turn over. Regulator 301/302 is activated via resistor 606 to hold the integrator at the positive peak value. Addionally the integrator voltage is fed via divider 612, 614 to the regulator. The amplitude is limited to 4 Vpp by clamping the resistor 613 and diodes 422/423 to the base of transistor 302 to avoid too high emitter base reverse voltage of 301.

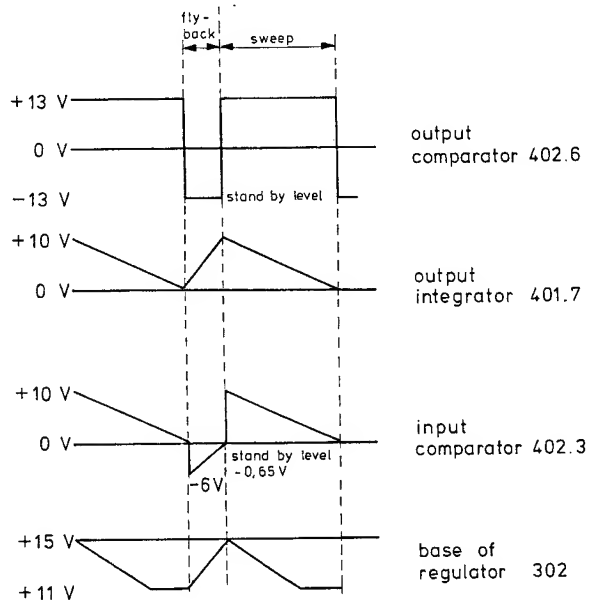
When pressing pushbutton TRIG a negative pulse is applied to the reference level of the comparator 402 via resistor 641/642 and the comparator is switched over from its STAND BY position; so one cycle starts with the slowly falling ramp of the integrator. Overmore triggering is possible by external TTL-signal on the falling edge via SWEEP TRIGGER INPUT.

When pressing pushbutton RESET a positive pulse is fed to the inverting input of the comparator. So fly-back is performed.

In HOLD mode current to the integrator is interrupted by SK 252/1a and the integrator remains at its instantaneous value.

The signal of the comparator is additionally applied via diode 427 to inverting switching transistor 306 to control the PEN LIFT output. During the sweep the PEN LIFT output is set to ground. In fly-back and stand-by position electronic switch 306 opens and +22 V is routed to the output.

In sweep mode the SWEEP OUTPUT is controlled by the integrator voltage, inverted via amplifier 401/2 and halved by divider 629/631 (see diagram chapter 3.2.4.).



sweep oscillator

4.1.2. Control section

The **general task** of the control section is to generate frequency proportional charging currents for the main oscillator. Input signals of this circuitry are the voltages at the potentiometers for the start and stop frequency, the output voltage of the sweep oscillator and the external sweep or modulation signal.

In **normal mode** (SWEEP OFF) the input of the amplifier 401.2 is set to ground; so the start potmeter is not active. As the output of the amplifier is U = 2 Uref-Usweep, where Uref = +5 V, +10 V are applied to the potmeter 648 for frequency setting. The voltages at the wipers are converted to currents via resistors 651, 652 and are fed to the summing amplifier 404. The output signal is converted into control voltages by current determining resistors 656 to 659, 662 and 664 for the 4 different frequency ranges. For the lowest range of the main oscillator the resistor is reduced by the factor 10 and the capacitors in the quadruple switch are not increased; so the size of the capacitors is limited.
Possibly scattered-in spikes via leads of the control section are suppressed via capacitor 531.

In **SWEEP mode** and stand-by operation the output of +10 V of the integrator of the sweep oscillator is connected to inverting amplifier 401/2 and to the start potentiometer 646. So 0 V is applied to the SWEEP OUTPUT socket; the (stop) FREQUENCY potmeter 648 is inactive. By this independent setting of the start and stop frequency for the sweep is achieved.
During the sweep the voltages at the two potmeters are decreasing and increasing in mutual direction until at the end of the sweep frequency potmeter 648 only is active as in normal mode.
When DUTY CYCLE is not pressed potmeter 673 is not active. Control voltage is 1 : 1 passed via impedance converter OP 405/transistor 312 to the **negative current source**, comprising amplifier 407 and transistor 314 and to the auxiliary current source 406. This negative current source is the reference for the positive current source the control of which is achieved via the symmetry control. The auxiliary current source 406 generates a current through resistor 667, which is fed to resistor 654. The resulting voltage generates the basic current for the **positive current source**, comprising amplifier 408 and transistor 313.

The **symmetry control** 315 to 318 was introduced to equalize for any inaccuracies caused by distortion and unbalance of the positive and negative current source and of the 4 transistors of the integrator. On the virtual earth side of the selected charging capacitor, the capacitor 515 will be charged by any unbalance, because it is inserted between charging capacitor and earth. This unbalance provides a control voltage for FET 318. The differential stage operates as a voltage/current converter, the output either putting current into the current source or taking out of it depending on the state of the positive current control. By this means, and by transistors with high current gain (i.e. negligible leakage current) in the quadruple switch circuit, any unbalance of the two loading currents is equalized, so reducing time symmetry errors of the signal.

When the DUTY CYCLE button is pressed the ratio of the two charging currents can be varied by means of the potentiometer DUTY CYCLE. So the duty cycle of the signal generated by the main oscillator is varied. At amplifier 405 divider 668/669/671 now is connected to the negative reference potential. So only a portion of the output voltage of the amplifier is fed back resulting in increased gain of 5. Furthermore resistors 672, 674 are switched to the negative reference potential, so that the DUTY CYCLE potmeter is active.
Variation of the control voltage at potentiometer 673 results in load current variation from 0.2 to 5; so the duty cycle is adjustable between 10 % and 90 %.

The period time in duty cycle mode is adjusted by 669 to the same value as in normal mode. Symmetric arrangement of the duty cycle circuitry guarantees equal period time of the main oscillator, when the DUTY CYCLE potmeter is turned.

Furthermore in duty cycle mode the symmetry control has to be switched off which is done by connecting the virtual zero of the quadruple switch to ground and by separating the output of the symmetry control from the positive current source.

4.1.3. Main oscillator

The wave form generator operates on the relaxation oscillator principle whereby the selected range capacitor first charged linearly in one direction and then charged linearly in the reverse direction to produce a triangular wave form. The frequency is determined by the selected range capacitor and the charging current, which can be influenced by a control voltage input derived from the frequency dial setting and, if required, by a sweep voltage input.

Switchover of the charging current is achieved by a two-level detector or comparator 328/329 which produces a reference signal when the selected integration capacitor has charged to a predetermined level. This reference signal is fed back to reverse the charge through the capacitor by means of the quadruple switching circuit.

The circuit operates as follows:
Assume that point a is positive. The integration capacitor will charge via transistor 321 and 320 (319 and 322 are switched off). At a predetermined level, transistor 328 of the comparator will switch on and open the current switch 332. Current will flow from the current source transistor 330 via 332 to switch off the transistor 329 of the comparator. Resulting negative reference voltage of the comparator at resistors 702/703 is routed to point a. The quadruple switch circuit will switch over. Integration capacitor will now be charged in the reverse direction via transistor 319 and 322. At a negative predetermined level, transistor 328 will switch off and also current switch 332. Current switch 331 will turn on because transistor 329 is active. So point a has positive voltage again and a new cycle starts. In this way, the triangular wave form is generated, the frequency of which depends on the charging capacitor and the charging current. The square wave is produced by 332.

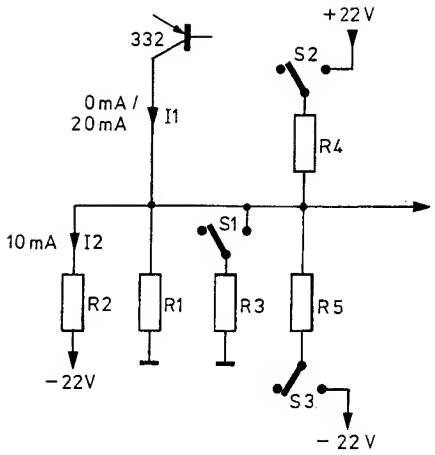
The basic part of the oscillator is the **quadruple switch** circuit with the frequency determining capacitors 516 - 523, selected by the front-panel pushbuttons FREQUENCY Hz. Under the control of the squarewave signal at point a, at each half-cycle two diagonal opposite transistors open while the other two close (i. e. 321, 320 open, 319, 322 close, vice versa). In this way the direction of the charging current is changed. To produce a triangular waveform that is time-symmetrical with respect to earth, one side of the charging capacitor is connected to virtual earth at the gate input of FET 318. In this way, the triangular signal is taken from the active side of the charging capacitor with respect to the 0 V line.

A high impedance FET **buffer** 323 avoids charging current variations occuring on the active side of the charging capacitor. Emitter follower 325/326 then connects the signal to the comparator 328/329.

To compensate for non-linearity in the frequency response of the highest range due to circuit delays in the comparator and the quadruple switch the lead 527 is inserted between oscillator and comparator.

The **comparator** 328/329 compares the instantaneous value of the capacitor charging potential against the reference level at the base 329 which is ±2 V square wave symmetrical. When the circuit attains one of the reference levels, it actuates the quadruple switch. At the same time, the comparator reference level is switched to the opposite polarity.
On the reference side of the comparator 2 current sources generate voltages via resistors 702, 703. The current of the first source, comprising transistor 330/diode 447, has twice the value of the second source, comprising resistors 704/705. According to the state of transistor 331 either the difference of the two sources results in a +2 V reference level or the second source alone generates -2 V reference level.

When **square wave** form is chosen, all switches are open, see figure below. The current of the current switch 332 (active ≙ 20 mA) flows via resistor R1. Negative current is added via resistor R2, resulting in zero-symmetrical square wave signal.
Switching in **positive or negative pulses** resistor R3 is added by S1. For R1 = R3 the square wave amplitude is halved. When R4 is activated by switch S2 or R5 by S3 positive or negative current is added, resulting in a square wave signal between 0 V and its positive value or between 0 V and its negative value. The total square wave signal is routed via a complementary emitter-coupled buffer stage 333/334 to the WAVE FORM switch 253. The signals are inverted by the power amplifier.



S 1 to S3 in position square wave
R1 = 714, 715, 716 + 710
R2 = 711
R3 = 717
S1 = 253/5b or 253/6a
S2 = 253/5a for negative pulses } at the
S3 = 253/6b for positive pulses } OUTPUT

The **TTL output** is taken from resistor 705 and routed via differential amplifier 335/336 and output switch 337. The output is taken directly from the emitter of 337 to the TTL OUTPUT socket at the rear side.

4.1.4. Sine shaper

The triangular signal of the oscillator is fed via WAVE FORM switch to the sine shaper circuit 412. The conversion from triangle to sine wave, with a distortion factor of 0.2 % typical, is achieved by non-linear wave form shaping at a diode-resistor network in the IC. The peaks of the triangular wave form are suppressed by a special compensating circuit in the integrated circuit.
Associated preset controls for shaping are potentiometers 808 and 812. The output on pin 1 is routed via a low-pass filter which serves to reduce the harmonic content of the sine wave at the highest frequencies. Preset 814 provides a control adjustment for the amplitude response. The output d.c. offset is preset to zero by 816. The emitter-follower 350/351 is used for impedance matching. The output is fed via the wave form selector switch and front-panel AMPLITUDE control 821 to the power amplifier.

4.1.5. Power amplifier

The power amplifier mainly consists of a voltage amplifier, output stage and the attenuator. Via the AMPLITUDE potmeter the level of the selected signal is applied to the voltage amplifier 352 - 355, which operates as a complementary cascode stage in pull-push arrangement to drive the power output. The output stage comprises 356/358 and 357/359 and operates with complementary darlingtons. Feedback is done via resistor 831 with parallel capacitor 556 to the input of the voltage amplifier, resulting in overall gain of ca. 15 dB.
The DC OFFSET is controlled by potmeter 822 via resistor 826 to the input of the voltage amplifier and can be set up to ±10 V ; see also note in chapter 3.2.1. Resistors 846/847, which determine the output impedance, feed the three-stage-attenuator. The front panel ATTENUATION pushbutton 253/1/2/3 permits selection of 10 dB, 20 dB and 30 dB by switching resistors 849 to 855 as L-section attenuator. For 600 Ω output impedance the signal is connected via resistor 857 to the OUTPUT socket.

4.1.6. Power supply

The required two power supplies of ±22 V are realized by means of four terminal adjustable voltage regulator 410 and 411. Positive voltage is adjusted by 781 and negative voltage by means of 784 to an accuracy of ±0.1 V.

4.2. ACCESS TO PARTS

Before dismantling the instrument, the safety regulations in accordance with para. 2.2. must be strictly observed.

4.2.1. Cabinet, see 2.5.

4.2.2. Knobs

- Remove the cap from the knob.
- Unscrew the nut and remove the knob.
- When replacing the knob, ensure that the white mark is correctly aligned with the text plate markings.

4.2.3. Text plate

- Remove the cabinet, see 2.5.
- Remove the turn-knobs, see 4.2.2.
- Remove the dial.
- Remove the plastic cover of the mains switch.
- The text plate can now be removed.
  Be careful:
  The textplate is fitted to the frontplate by double sided adhesive tape.

4.2.4. Pushbutton unit

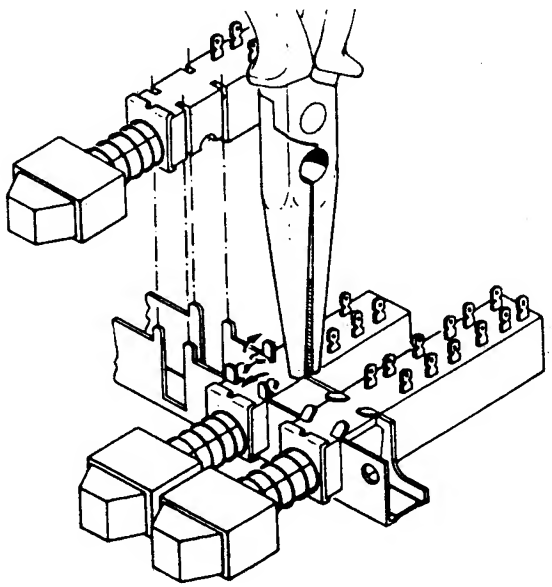
Replacing a pushbutton lever.

The single pushbutton lever can be replaced from the front.

- Push the spring towards the pushbuttons.
- Remove the wire strap and/or lift the plastic reed between the contacts
- Carefully tear the pushbutton lever out of the pushbutton.

Replacing a switch of the pushbutton unit

- Straighten the 4 retaining lugs of the relevant switches as shown in the figure below.
- Break the body of the relevant switch by means of a pair of pliers and remove the pieces. The soldering pins are then accessible.
- Remove the soldering pins and clean the holes in the printed circuit board (e.g. with a suction soldering iron).
- Bend the 4 retaining lugs back to their original positions.
- Solder the new switch on to the printed circuit board.



4.3. CHECK AND ADJUSTMENT

4.3.1. General

- The limits mentioned in this paragraph are valid only for a newly adjusted instrument and therefore might deviate from the values as stated in paragraph 1.2. "Technical Data".
- Adjustment of the instrument is only permitted after a warm-up time of at least 30 minutes at an ambient temperature of (+23 ±3)° C and when connected to a mains voltage of 220 V ±5 %. The cabinet must be closed.
- The printed circuit board is mounted overhead. Nevertheless all trimming potentiometers and capacitors are accessible from the top. For adequate temperature stability during adjustment, the cabinet should be removed only for a short time and so far that the required adjusting element is just accessible.
- If not explicitely stated otherwise, the voltage potentials refer to the relevant contact measured against circuit earth ($\perp_o$).
- The following abbreviations are used for setting and measuring instruments:

X	= Button pressed	
–	= Button not pressed/unlocked	
o	= Button only tipped	
D.V.M. (d.c.)	= Digital voltmeter for DC measurements	e.g. PM 2534
OSC.	= Oscilloscope	e.g. PM 3055
C	= Counter	e.g. PM 6665
Fg	= Function generator	e.g. PM 5132
DA	= Distortion analyzer	e.g. HP 333A
50 Ω	= 50 Ω terminating resistor	e.g. PM 9585

4.3.2. Preparations

- All trimming potentiometers and capacitors in mid-position; (only for complete new adjustment).
- Turn dial potentiometer to extreme counter clockwise position.
  Position dial such that the 0,4 graduation on the dial is positioned to the text plate mark.
- Solder joints A to K must be closed. To be opened for failure detection only.
- Terminate the OUTPUT by a 50 Ohm resistor.

4.3.3. General functional test

- Actuate all buttons one after the other for rough functional test of the generator by means of an oscilloscope connected to the OUTPUT socket.
- Control the TTL output.
- Roughly control the output voltage at the SWP VOLTAGE socket during the internal sweep.

4.4. SAFETY INSPECTION AND TESTS AFTER REPAIR AND MAINTENANCE IN THE PRIMARY CIRCUIT

4.4.1. General directives

- Take care that creepage distance and clearances have not been reduced
- Before soldering, wires:
  should be bent through the holes of solder tags, or wrapped round the tag in the form of an open U, or, wiring ridigity shall be maintained by cable clamps or cable lacing.
- Replace all insulating guards and -plates.

4.4.2. Safety components

Components in the primary circuit may only be renewed by components selected by Philips, see also chapter 4.5.1.

4.4.3. Checking the protective earth connection

The correct connection and condition is checked by visual control and by measuring the resistance between the protective-lead connection at the plug and the cabinet/frame. The resistance shall not be more than 0.5 Ω. During measurement the mains cable should be moved. Resistance variations indicate a defect.

4.4.4. Checking the insulation resistance

Measure the insulation resistance at U = 500 Vdc between the mains connections and the protective lead connections. For this purpose set the mains switch to ON. The insulation resistance shall not be less than 2 MΩ.

Note:
2 MΩ is a minimum requirement at 40 ^{o}C and 95 % relative humidity. Under normal conditions the insulation resistance should be much higher (10 to 20 MΩ).

4.5. SPARE PARTS

4.5.1. General

Standard Parts
Electrical and mechanical parts replacement can be obtained through your local Philips organisation or representative. However, many of the standard electronic components can be obtained from other local suppliers. Before purchasing or ordering replacement parts, check the parts list for value, tolerance, rating and description.

NOTE:
Physical size and shape of a component may affect instrument performance, particularly at high frequencies. Always use direct-replacement components, unless it is known that a substitute will not degrade instrument performance.

Special Parts
In addition to the standard electronic components, some special components are used:

- Components, manufactured or selected by Philips to meet specific performance requirements.
- Components which are important for the safety of the instrument, marked with 'S' in the parts list.

ATTENTION:
Both type of components may only be replaced by components obtained through your local Philips organisation.

4.5.2. Mechanical parts, miscellaneous, electrical parts not on units

Item	Fig.	Quantity	Order number	Description	
01	5	1	5322 447 94324	cover, grey	
01	5	1	5322 447 90395	cover, brown	
02	5	4	5322 462 44174	foot (bottom side), grey	
02	5	4	5322 462 10222	foot (bottom side), brown	
03	5	2	5322 520 34164	bearing bush	
04	5	2	5322 530 84075	spring	
05	5	2	5322 528 34101	rachet	
06	5	2	5322 532 54425	ring for handle, grey	
06	5	2	5322 532 51481	ring for handle, brown	
07	5	2	5322 498 54048	arm for handle	
08	5	1	5322 498 54051	carrying handle	
09	5	2	5322 414 64053	knob, grey	
09	5	2	5322 414 30043	knob, brown	
11	5	1	5322 447 94188	back frame	
12	5	4	5322 462 44176	foot (rear side)	
13	-	1	5322 502 14164	coin-slot screw (rear side)	
14	-	1	4822 530 70124	locking washer (rear side)	
15	5	1	5322 414 74042	cover for knob(scale), grey	
15	5	1	5322 414 70043	cover for knob(scale), brown	
16	5	1	5322 414 74019	cover for knob(switch), grey	
16	5	1	5322 414 70015	cover for knob(switch), brown	
17	5	3	5322 414 74014	cover for knob, grey	
17	5	3	5322 414 70017	cover for knob, brown	
18	5	3	5322 414 74015	cover for small knob, grey	
18	5	3	5322 414 70016	cover for small knob, brown	
19	5	1	5322 459 24076	front frame	
21	6	1	5322 401 14275	cable clamp	*S
22	6	1	5322 321 14048	mains cable 1850	*S
23	6	1	5322 325 60119	lead through	*S
24	6	1	4822 253 30012	fuse 200 mAT	*S
566	6	1	5322 121 44028	27N 2x2N7 250 V, Line filter	*S
26	6	3	5322 405 94178	print holder	
29	5	22	5322 414 25851	knob for pushbutton, grey	
29	5	22	5322 414 20033	knob for pushbutton, brown	
30	5	1	5322 414 34239	knob for switch, grey	
30	5	1	5322 414 30071	knob for switch, brown	
31	5	3	5322 414 34083	knob, grey	
31	5	3	5322 414 30069	knob, brown	
32	5	2	5322 414 34075	knob small (4mm axle), grey	
32	5	2	5322 414 30053	knob small (4mm axle), brown	
33	5	1	5322 414 34096	knob small (1/8" axle), grey	
33		1	5322 414 30041	knob small (1/8" axle), brown	
34	5	1	5322 414 44076	dial mounted, grey	
34	5	1	5322 414 40024	dial mounted, brown	
35	5	1	5322 414 74047	locating mark, grey	
35	5	1	5322 414 70044	locating mark, brown	
870-875	5	6	5322 267 10004	BNC-socket	
251	5/6	1	5322 276 14393	mains switch	*S

*S = safety component

Item	Fig.	Quantity	Order number	Description
252/1/2/4	4	3	5322 276 10959	pushbutton switch
252/3/5	4	2	5322 276 10961	pushbutton switch
252/6	4	1	5322 276 14221	pushbutton switch
253/1-3	7	3	5322 276 14221	pushbutton switch
253/4/7-16	7	11	5322 276 14271	pushbutton switch
253/5/6	7	2	5322 276 10961	pushbutton switch
38	6	1	5322 273 64059	rotary switch
39	-	1	5322 405 74027	print holder unit 2
40	7	5	5322 255 44265	heat sink
41	7	2	5322 255 44037	heat sink
42	-	-	5322 390 24013	silicon paste DC 340
648	6	1	5322 105 24014	potmeter 5KO/5
673	6	1	5322 103 64043	potmeter 5KO/5
601,647	6	2	4822 101 20441	carbon potm. 10K lin.
646	6	1	4822 101 20416	carbon potm. 4K7 lin.
821	6	1	4822 101 20431	carbon potm. 2K2 lin.
822	6	1	5322 101 64029	carbon potm. 22K lin.+switch
751	6	1	5322 146 24486	mains transformer *S

*S = Safety component

4.5.3. Electrical parts

Some parts are listed in chapter 4.5.2.

INTEGRATED CIRCUITS

401	5322 209 85512	IC MC1458N
402	5322 209 85254	IC MUA741CV
404,405	5322 209 86056	IC LM308AN
406-408	5322 209 85254	IC MUA741CV
410	5322 209 85565	IC 78GCU1
411	5322 209 86349	IC 79GCU1
412	5322 209 84778	IC OQ0011

TRANSISTORS

301,302	4822 130 44197	BC558B
303	5322 130 44509	BFQ16
304,305	4822 130 40937	BC548B
306	4822 130 41095	BC337-16
315, 316	4822 130 44197	BC558B
317	4822 130 40937	BC548B
318,323	4822 130 41024	BF245B
310,319	5322 130 44594	2N3964
311,312	4822 130 40937	BC548B
313	4822 130 44197	BC558B
314,324	4822 130 40937	BC548B
320,322	4822 130 44196	BC548C
321	5322 130 44594	2N3964
325,328	4822 130 40937	BC548B
326,327	5322 130 44034	2N2219A
329	4822 130 40937	BC548B
330	5322 130 40021	2N2905
331-333	4822 130 44197	BC558B
334-336	4822 130 40937	BC548B
337,350	4822 130 44197	BC558B
351	4822 130 40937	BC548B

352,354	5322 130 40468	2N2905A
353,355	5322 130 44034	2N2219A
356	4822 130 40959	BC 547B
357	4822 130 44568	BC 557B
358	5322 130 44034	2N 2219A
359	5322 130 40468	2N 2905A

DIODES

421	5322 130 34321	1N4151 (BAW62)
422,432	4822 130 34297	BZX79-C10
423,424	5322 130 34321	1N4151 (BAW62)
425,426	4822 130 34278	BZX79-C6V8
427,431	5322 130 34321	1N4151 (BAW62)
428,430	4822 130 34278	BZX79-B6V8
429	4822 130 30229	AAZ 15
433,434	5322 130 34321	1N4151 (BAW62)
435,436	4822 130 34278	BZX79-C6V8
437,438	4822 130 34174	BZX79-C4V7
439-442	4822 130 34195	BZX79-C13
443	4822 130 30862	BZX79-B9C1
444	4822 130 34167	BZX79-B6V2
445,446	5322 130 34321	1N4151 (BAW62)
447	4822 130 34047	BZX-C1V5
451	5322 130 32031	RECTIFIER SKB2/08L5A
452,453	4822 130 34195	BZX79-B13
454	4822 130 34048	BZX75-C2V8
455,456	5322 130 34321	1N4151 (BAW62)

COILS

471,472	5322 158 14018	33 MUH
473	5322 158 10276	4,7 MUH
474	5322 158 10283	150 MUH

CAPACITORS

ITEM	ORDERING NUMBER	FARAD	TOL (%)	VOLTS	REMARKS
501	5322 121 40323	100N	5	100 .	POLYESTER FOIL
502,521	5322 121 40197	1 MU	5	100 .	POLYESTER FOIL
503,522	5322 121 54213	6MU8	5	100 .	POLYSTYRENE FOIL
504,523	5322 121 40283	3MU3	5	100	POLYESTER FOIL
505	4822 122 30027	1N	2	100 .	CERAMIC PLATE
506,529	5322 124 24202	2MU2		63 .	ELECTROLYTIC
508,507	4822 122 30128	4N7	10	100 .	CERAMIC PLATE
509	4822 122 30114	2N2	10	100 .	CERAMIC PLATE
511,512	4822 124 20499	22MU		40 .	ELECTROLYTIC
513,514	4822 122 31067	33P	2	100 .	CERAMIC PLATE
515	5322 121 40323	100N	10	100 .	POLYESTER FOIL
516	5322 125 54068	2-22P		100 .	TRIMMER
517	4822 122 31074	56P	2	100 .	CERAMIC PLATE
518	5322 121 54085	976P	1	125 .	POLYSTYRENE FOIL
519	5322 121 54154	10N	1	63 .	POLYSTYRENE FOIL
520	5322 121 54124	100N	1	63 .	POLYSTYRENE FOIL
524,525	4822 122 31175	1N	10	100 .	CERAMIC PLATE
526,528	4822 122 30103	22N	-20+80	63 .	CERAMIC PLATE
527	4822 122 31074	56P	2	100 .	CERAMIC PLATE
530	5322 124 24202	2MU2		63 .	ELECTROLYTIC
531	4822 122 31178	680P	10	100 .	CERAMIC PLATE
532	5322 121 40324	15N	10	250 .	POLYESTER FOIL
533	4822 122 30128	4N7	10	100 .	CERAMIC PLATE
540	5322 121 44138	47N	20	250 .	POLYESTER FOIL
542,551	5322 121 40323	100N	20	100 .	POLYESTER FOIL
543,544	4822 124 20798	3300MU		40 .	ELECTROLYTIC

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
545,546	4822 124 20583	1MU		63 .	ELECTROLYTIC
547,548	4822 124 20499	22MU		40 .	ELECTROLYTIC
550,552	4822 122 30103	22N	-20+80	63 .	CERAMIC PLATE
553	4822 122 31054	10P	2	100 .	CERAMIC PLATE
555,565	4822 122 31069	39P	2	100 .	CERAMIC PLATE
556	4822 125 50062	2-10P		100 .	TRIMMER
557,558	4822 122 30128	4N7	10	100 .	CERAMIC PLATE
559,560	4822 122 30103	22N	-20+80	63 .	CERAMIC PLATE
561,562	5322 122 30108	100N	10	50	POLYESTER FOIL
566	4822 122 31063	22P	2	100 .	CERAMIC PLATE

RESISTORS

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
602,623	4822 100 10029	2K2		LIN .	TRIMMING POTM
603,614	5322 116 54619	10K	1	MR25 .	METAL FILM
604	5322 116 54497	226	1	MR25 .	METAL FILM
606	5322 116 55458	442K	1	MR25 .	METAL FILM
607	5322 116 55276	13K3	1	MR25 .	METAL FILM
608	4822 100 10037	1K	1	LIN .	TRIMMING POTM
609	5322 116 54661	34K8	1	MR25 .	METAL FILM
611	5322 116 50579	3K16	1	MR25 .	METAL FILM
612	5322 116 54629	14K	1	MR25 .	METAL FILM
613	5322 116 50484	4K64	1	MR25 .	METAL FILM
615	5322 116 50672	51K1	1	MR25 .	METAL FILM
616	5322 116 55258	511K	1	MR25 .	METAL FILM
617,618	5322 116 54686	75K	1	MR25 .	METAL FILM
619	5322 116 54549	1K0	1	MR25 .	METAL FILM
621,629	5322 116 54643	20K5	1	MR25 .	METAL FILM
622,643	5322 116 54696	100K	1	MR25 .	METAL FILM
624,636	5322 116 54619	10K	1	MR25 .	METAL FILM
625,628	5322 116 50748	10K	0,1	MR25 .	METAL FILM
626	5322 116 55183	20K5	0,1	MR25 .	METAL FILM
627	5322 116 54236	6K04	0,1	MR25 .	METAL FILM
631	5322 116 54643	20K5	1	MR25 .	METAL FILM
632	5322 116 50479	15K4	1	MR25 .	METAL FILM
633	5322 116 50572	12K1	1	MR25 .	METAL FILM
637,638	5322 116 50484	4K64	1	MR25 .	METAL FILM
639,642	5322 116 54619	10K	1	MR25 .	METAL FILM
641	5322 116 50608	6K19	1	MR25	METAL FILM
644	5322 116 54012	6K81	1	MR25 .	METAL FILM
645,666	5322 116 54619	10K	1	MR25 .	METAL FILM
649	5322 101 14011	100		LIN .	TRIMMING POTM
650	5322 116 55304	46K4	0,25	MR25 .	METAL FILM
651	5322 116 55508	93K1	0,25	MR25 .	METAL FILM
652	5322 116 54976	88K7	0,25	MR25 .	METAL FILM
653,660	5322 116 50484	4K64	1	MR25 .	METAL FILM
* 654	5322 116 55038	301	0,1	MR25 .	METAL FILM
* 656	5322 116 55033	1K05	1	MR25 .	METAL FILM
657	5322 101 14051	220		LIN .	TRIMMING POTM
658	5322 116 55328	11K	1	MR25 .	METAL FILM
659,662,664	5322 101 14008	2K2		LIN .	TRIMMING POTM
661	5322 116 54619	10K	1	MR25 .	METAL FILM
663,670	4822 100 10035	10K		LIN .	TRIMMING POTM
710	4822 100 10254	1K		LIN .	TRIMMING POTM
665	5322 116 50484	4K64	1	MR25 .	METAL FILM
667	5322 116 55038	301	0,1	MR25 .	METAL FILM
668	5322 116 54557	1K21	1	MR25 .	METAL FILM
669,719	4822 100 10038	470		LIN .	TRIMMING POTM
671	5322 116 54011	5K62	1	MR25 .	METAL FILM
672,674	5322 116 54529	619	1	MR25 .	METAL FILM
675,679	5322 116 55038	301	0,1	MR25 .	METAL FILM
676,677	5322 116 54592	4K02	1	MR25 .	METAL FILM
678	5322 116 50593	16K2	1	MR25 .	METAL FILM
680	4822 100 10035	10K		LIN .	TRIMMING POTM
681,682	5322 116 54585	3K48	1	MR25 .	METAL FILM
683,684	5322 116 54472	105	1	MR25 .	METAL FILM
685	5322 116 50767	2K15	1	MR25 .	METAL FILM
686	5322 116 50586	1K54	1	MR25 .	METAL FILM
687,723	5322 116 54562	1K4	1	MR25 .	METAL FILM
688	5322 116 54585	3K48	1	MR25 .	METAL FILM
* 655	5322 116 50581	2K49	1	MR25 .	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
689,691	5322 116 54606	7K15	1	MR25 .	METAL FILM
690,725	5322 116 54567	1K69	1	MR25 .	METAL FILM
692,726	5322 116 50581	2K49	1	MR25 .	METAL FILM
693	5322 116 50571	715	1	MR25 .	METAL FILM
694,709	5322 116 54835	511	1	MR30 .	METAL FILM
695,705	5322 116 54557	1K21	1	MR25 .	METAL FILM
696	5322 116 54539	806	1	MR25 .	METAL FILM
697,699	5322 116 50669	205	1	MR25 .	METAL FILM
698	5322 116 50414	2K87	1	MR25 .	METAL FILM
700	5322 116 54472	105	1	MR25 .	METAL FILM
701	5322 116 50729	4K22	1	MR25 .	METAL FILM
702	5322 116 54492	178	1	MR25 .	METAL FILM
703	5322 116 54446	56R2	1	MR25 .	METAL FILM
704	5322 116 50555	1K27		MR25 .	METAL FILM
706	5322 116 54646	23K7	1	MR25 .	METAL FILM
707	4822 100 10051	22K		LIN .	TRIMMING POTM
708	4822 101 10108	100		LIN .	TRIMMING POTM
711,715	5322 116 50675	2K26	1	MR25 .	METAL FILM
712,713	5322 116 50767	2K15	1	MR25 .	METAL FILM
714	5322 116 54529	619	1	MR25 .	METAL FILM
716	5322 116 50515	1K78	1	MR25 .	METAL FILM
717	5322 116 54514	340	1	MR25 .	METAL FILM
718,720	5322 116 50524	3K01	1	MR25 .	METAL FILM
721	5322 116 54608	7K5	1	MR25 .	METAL FILM
722	5322 116 55451	487	1	MR25 .	METAL FILM
724	5322 116 54469	100	1	MR25 .	METAL FILM
727	5322 116 54576	2K37	1	MR25 .	METAL FILM
728	5322 116 50729	4K22	1	MR25 .	METAL FILM
729	5322 116 54549	1K	1	MR25 .	METAL FILM
731	5322 116 50524	3K01	1	MR25 .	METAL FILM
732,839	5322 116 50621	536	1	MR25 .	METAL FILM
778	5322 116 51052	42R2	1	MR25 .	METAL FILM
779	5322 116 54696	100K	1	MR25 .	METAL FILM
780	5322 116 50728	1K87	1	MR25 .	METAL FILM
781,784	4822 100 10075	100		LIN .	TRIMMING POTM
782,785	5322 116 54525	511	1	MR25 .	METAL FILM
783,813	5322 116 50509	4K87	1	MR25 .	METAL FILM
807,809	5322 116 54613	8K66	1	MR25 .	METAL FILM
808,812	4822 100 10038	470		LIN .	TRIMMING POTM
810	5322 116 54743	301K	1	MR25 .	METAL FILM
811	5322 116 54549	1K	1	MR25 .	METAL FILM
814	4822 100 10035	10K		LIN .	TRIMMING POTM
815,817	5322 116 50414	2K87	1	MR25 .	METAL FILM
816	4822 100 10038	470		LIN .	TRIMMING POTM
818	5322 116 50509	4K87	1	MR25 .	METAL FILM
820	5322 116 50664	2K05	1	MR25 .	METAL FILM
823	5322 116 50679	237	1	MR25 .	METAL FILM
824	4822 100 10079	47K		LIN .	TRIMMING POTM
825	5322 116 54686	75K2	1	MR25 .	METAL FILM
826	5322 116 54646	23K7	1	MR25 .	METAL FILM
827,830	5322 116 55482	715	1	MR52 .	METAL FILM
828,829	5322 116 50527	33R2	1	MR25 .	METAL FILM
831	5322 116 54624	11K5	1	MR25 .	METAL FILM
832,833	5322 116 50493	28R4	1	MR25 .	METAL FILM
834,836	5322 116 54009	562	1	MR25 .	METAL FILM
835	5322 116 54637	17K8	1	MR25 .	METAL FILM
837,838	5322 116 54014	23R7	1	MR25 .	METAL FILM
840,841	5322 116 54472	105	1	MR25 .	METAL FILM
842	4822 116 51152	27	5	PR52 .	METAL FILM
843,844	5322 116 54348	10	5	PR52 .	METAL FILM
845,846	4822 116 51152	27	5	PR52 .	METAL FILM
847	5322 116 54956	24	5	MR25 .	METAL FILM
848,856	5322 116 50583	5K9	1	MR25 .	METAL FILM
849	5322 116 50586	1K54	1	MR25 .	METAL FILM
850	5322 116 54442	51R1	1	MR25 .	METAL FILM
851	5322 116 55481	442	1	MR52 .	METAL FILM
852	5322 116 54445	54R9	1	MR25 .	METAL FILM
853	5322 116 54458	73R2	1	MR25 .	METAL FILM
854,855	5322 116 54949	215	1	MR52 .	METAL FILM
857	5322 116 54806	549	1	MR30 .	METAL FILM

4.3.4. Table of checks and adjustments

Seq.	FREQUENCY											WAVE FORM						AMPLITUDE							DC OFFS.			DUTY CYCLE					SWEEP												measuring point							adjustment	meas. quantity	measured value	remark
	dial	OFFSET			range													attenuator			knob							pushbutton					PERIOD-s.				knob		push-button				START FRQ.		socket (front)		socket (rear)				point				
		-5%	0	+5%	x .1	x 1	x 10	x 100	x 1 K	x 10 K	x 100 K	∿	∧	⊓⊔	⊓_	⊔‾	DC	10 dB	20 dB	30 dB	min	1/2	max	50Ω/600Ω	-10	0	+10	ON		10%	50 %	90%	OFF	1	10	100	x .05	x 1	HOLD	RESET	STD BY CONT	Trig	min	20	OUTP.	SWP IN	TTL	SWP OUT	SWP TRG	PEN LIFT					
1. Power supply																																																							
1.1.	20		x						x				x									x				OFF							x																			547	781	V_{DC}	22V ±0,1V	
1.2.	20		x						x				x									x				″							x																			548	784	V_{DC}	22V ±0,1V	
2. controlled current source, main oscillator																																																							
2.1.	1		x						x				x									x				″							x																			405/3-407/2	680	V_{DC}	0 ±0,1mV	
2.2.	1		x						x				x									x				″							x																			405/3-406/2	670	V_{DC}	0 ±0,1mV	
2.3.	1		x						x				x									x				″							x																			408 2/3	663	V_{DC}	0 ±0,1mV	
2.4.	1		x		x								x									x				″							x																			base 329	708	V_{DC}	3.8 V ... 3.85 V	difference between pos. and neg. value
2.5.	20		x						x				x									x				″							x																			253 96/2	707	V_{DC}	0 ±0,05V	
2.6.	20		x						x				x									x				″							x														x					664	f	20kHz ±0,1 kHz	
2.7.	1		x						x				x									x				″							x														x					649	f	1kHz ±10Hz	check 2.6 again after this
2.8.	1 .. 20		x						x				x									x				″							x														x						f	nom value ±2 %	check at scale graduations 1, 2, 3, 5, 7, 10, 15, 20
2.9.	20		x							x			x									x				″							x														x						f	200 kHz ±4kHz	
2.10.1	20		x								x		x									x				″							x														x					516	f	2MHz ±10kHz	
2.10.2	4		x								x		x									x				″							x														x						f	400kHz±8kHz	if necessary, alter C527 and repeat seq. 2.10.1, 2.10.2.
2.11.	20		x					x					x									x				″							x														x						f	2kHz ±40Hz	
2.12.	20		x				x						x									x				″							x														x					662	T	5ms ±0,05 ms	
2.13.	20		x			x							x									x				″							x														x					659	T	50ms ±0,5 ms	
2.14.	20		x		x								x									x				″							x														x					657	T	500ms ±5 ms	
2.15.	2		x		x				x				x									x				″							x														x						T	5s ± 0,2 s	
2.16.	10		←●→						x				x									x				″							x														x						f	(−5 ±1) % (+5 ±1) %	
2.17.	20		x						x				x									x				″		x			x		x														x					669	f	20kHz ±0,1 kHz	
2.18.	20		x						x				x									x						x			←●→		x														x						T		upper top must be adjustable within 5 .. 45 µs
2.19.	10		x						x								x					x				x							x												x							824	V_{DC}	0 ±20 mV	
2.20.	10		x					x							x							x				x							x												x							719			adjust lower top to 0 V
2.21.	10		x					x								x						x				x							x												x							710			adjust upper top to 0 V
3. sweep control																																																							
3.1.	20		x						x				x									x												x							x			x				x				608	V_{DC}	0 V ±5 mV	
3.2.	20		x						x				x									x				x								x			x				x			x			x						f	20 kHz ±1 kHz	
3.3.	20		x						x				x									x				x								x			x				x		x				x						f	≤ 100 Hz	
3.4.	20		x						x				x									x				x								x			x							x				x B				623	V_{pp}	0 V ±5 mV	lowest point of triangular wave
3.5.	20		x						x				x									x				x								x			x						x							x		602	T	50 ms ±0,5 ms	
3.6.	20		x						x				x									x				x								x				x					x							x			T	1 s ±0,2 s	
3.7.	20		x						x				x									x				x									x		x						x							x			T	500 ms ±50 ms	
3.8.	20		x						x				x									x				x										x	x						x							x			T	5 s ±0,5 s	
3.9.	20		x						x				x									x				x										x	x				x	x	x				x						f		a single sweep must be performed
3.10.	20		x						x				x									x				x										x	x			x		x	x				x						f		running sweep must be reset to f_{START}
3.11.	20		x						x				x									x				x										x	x		x			x	x				x						f		pushing the button, frequency must keep standing
3.12.	20		x						x				x									x				x								x			x					x	x						A	x			V_{DC}	22 V/0 V	for 50ms 0 V after H/L going edge

A: TTL-Signal, f ≤ 10 Hz, at **SWEEP TRIG INPUT**

B: Germanium diode AAZ in forward direction connected to SWEEP OUT

Seq.	FREQUENCY: dial	FREQUENCY: OFFSET	FREQUENCY: range	WAVE FORM	AMPLITUDE: attenuator	AMPLITUDE: knob	DC OFFS.	DUTY CYCLE: pushbutton	DUTY CYCLE	SWEEP: PERIOD-s.	SWEEP: knob	SWEEP: push-button	SWEEP: START FRQ.	measuring point: socket (front)	measuring point: socket (rear)	measuring point: point	adjustment	meas. quantity	measured value	remark
		−5% 0 +5%	x.1 x 1 x 10 x 100 x 1 K x 10 k x 100 K	~ ⩘ ⎍ ⎍ ⎍ DC	10 dB 20 dB 30 dB	min 1/2 max 50Ω/600Ω	−10 0 +10	ON pushbutton	10 % 50 % 90 %	OFF 1 10 100	x.05 x 1	HOLD RESET STD BY CONT Trig	min 20	OUTP. SWP IN	TTL SWP OUT SWP TRG PEN LIFT					
4.1.	10	x	x	x			◂●▸			x				x				V DC	−5 ±0,5 V +5 ± 0,5 V	
4.2.	5	x	x	x		x	x			x				x			556	⎍	optimal waveform	rise time ⩽ 75 n sec.
4.3.	10	x	x	x		x	x			x				x			808 812	K	< 0,3 %	
4.4.	10	x	x	x		x	x			x				x			816	V DC	0 ±20 mV	
4.5.	20	x	x x	x		x	x			x	x		x	x	C		814	V pp		optimize frequency response
4.6.	5		x x	x		x	x			x				x				K	<2 %	
4.7.	10	x	x	●▸●▸●▸●▸●▸●▸●		x	x			x				x				V pp	15 V ±1 V 7,5 ±0,5 V	
4.8.	10	x	x	x	●▸●▸●▸●	x	x			x				x				atten uation	nom. value ±0,2 dB	
4.9.	10	x	x	x		x	x			x				x				V pp	1,5 ±0,3 V	
4.10.	10	x	x	x		x	x			x				x				V pp	2,3 ±0,15 V	
4.11.	10	x	x	x		x	x			x					x			V p	4,5 ... 5 V 0 ± 0,2 V	TTL-output
4.12.	0.4	x	x	x		x	x			x					D x			V DC f	0 ... +5 V 100 Hz ... 2 kHz	

4. sine shaper, amplifier, attenuator

C: Connect SWEEP OUT to external x-input of oscilloscope

D: DC voltage to be fed in

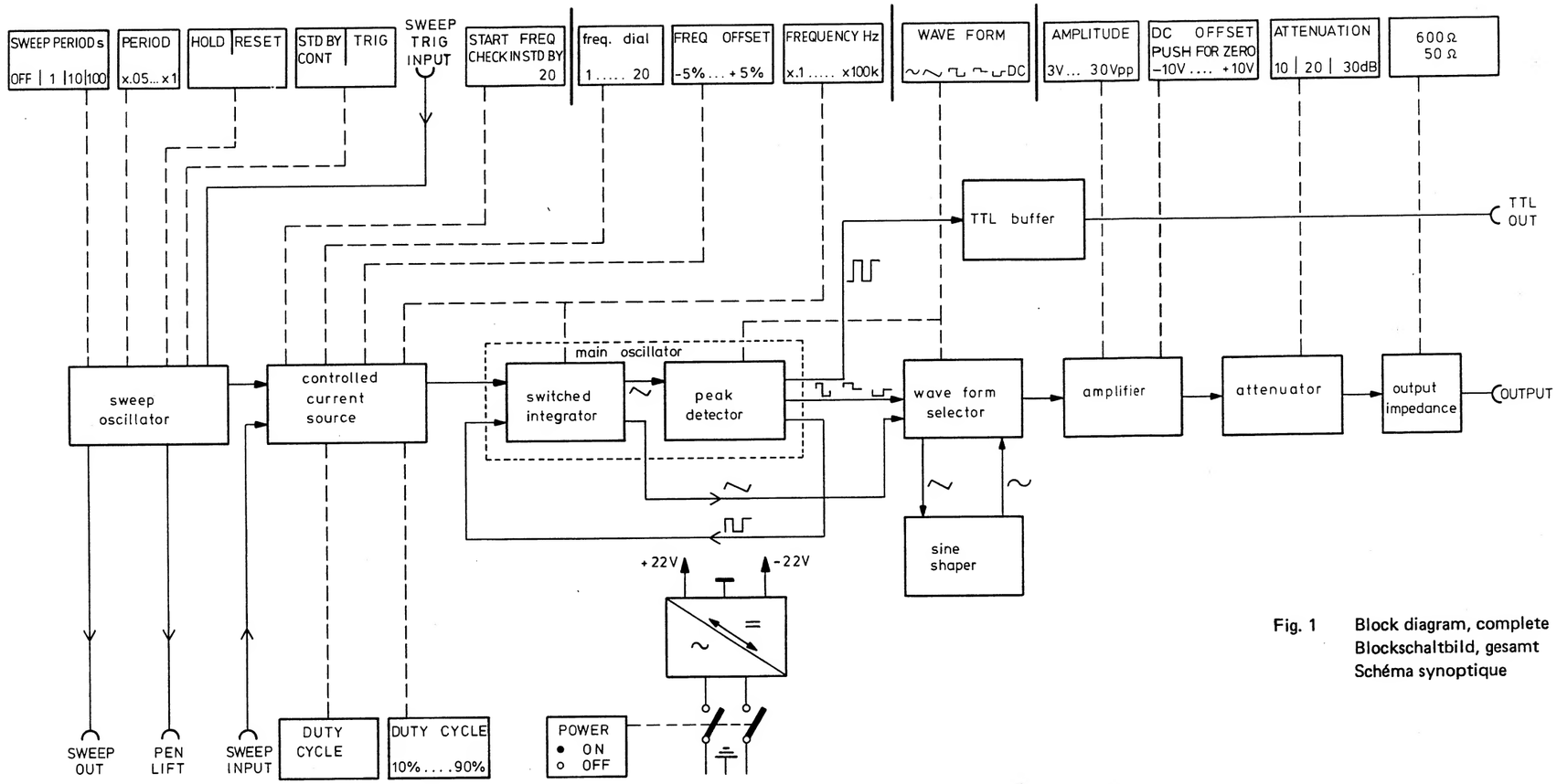


Fig. 1 Block diagram, complete
Blockschaltbild, gesamt
Schéma synoptique

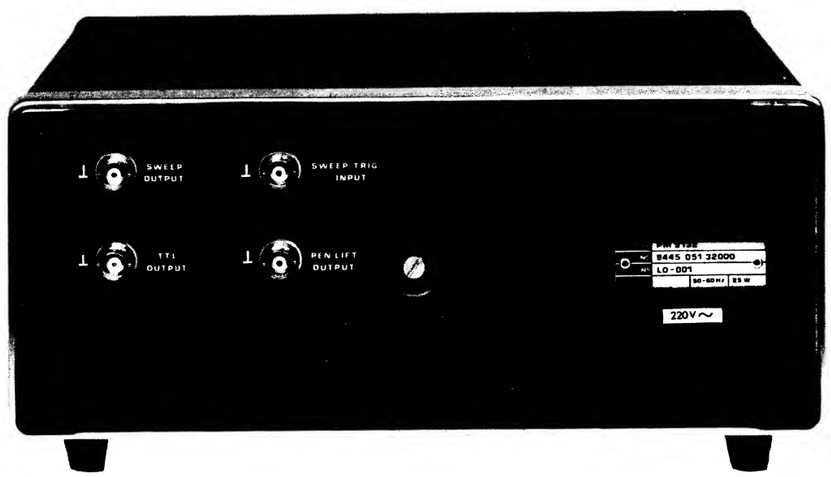


Fig. 3 Rear view
Rückansicht
Face arriere

Fig. 2 Front view
Frontansicht
Face avant

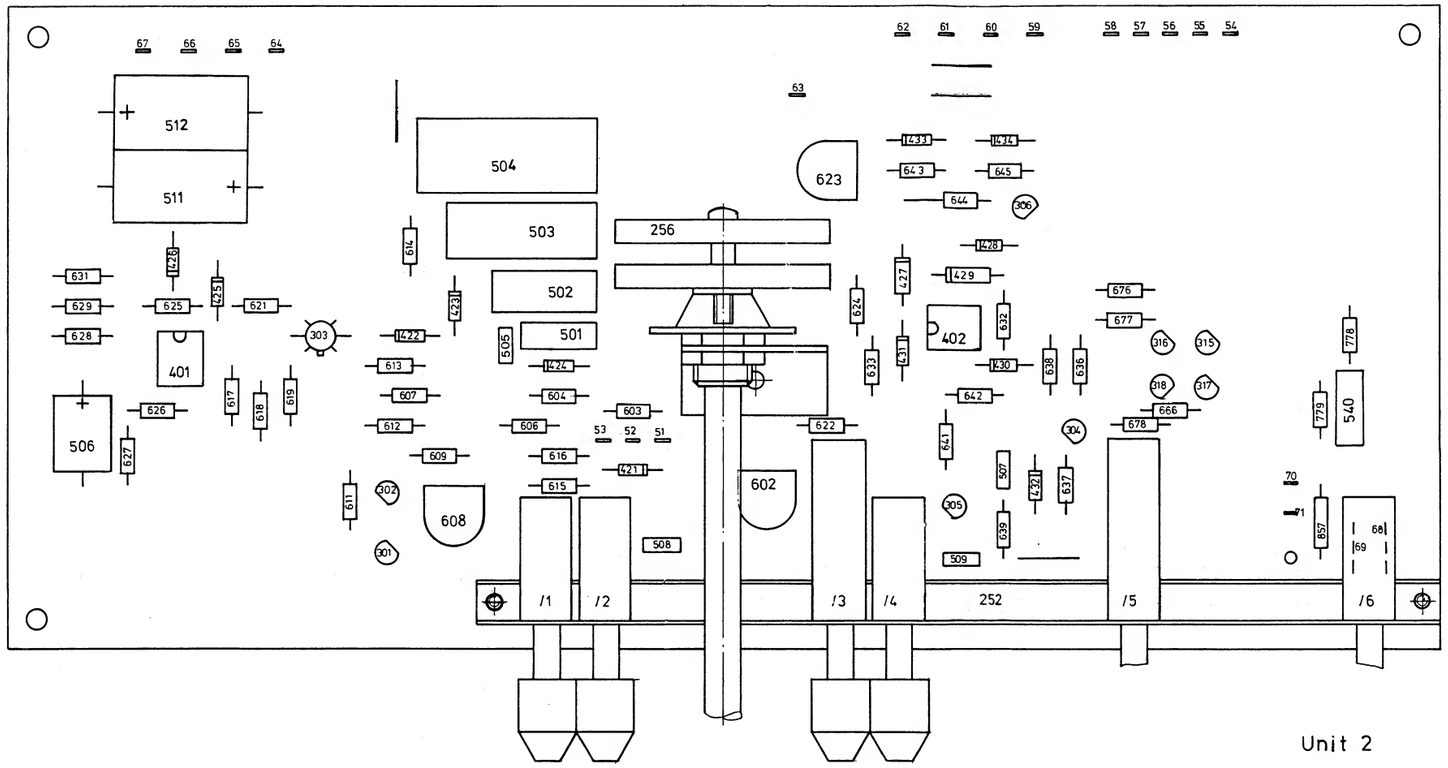
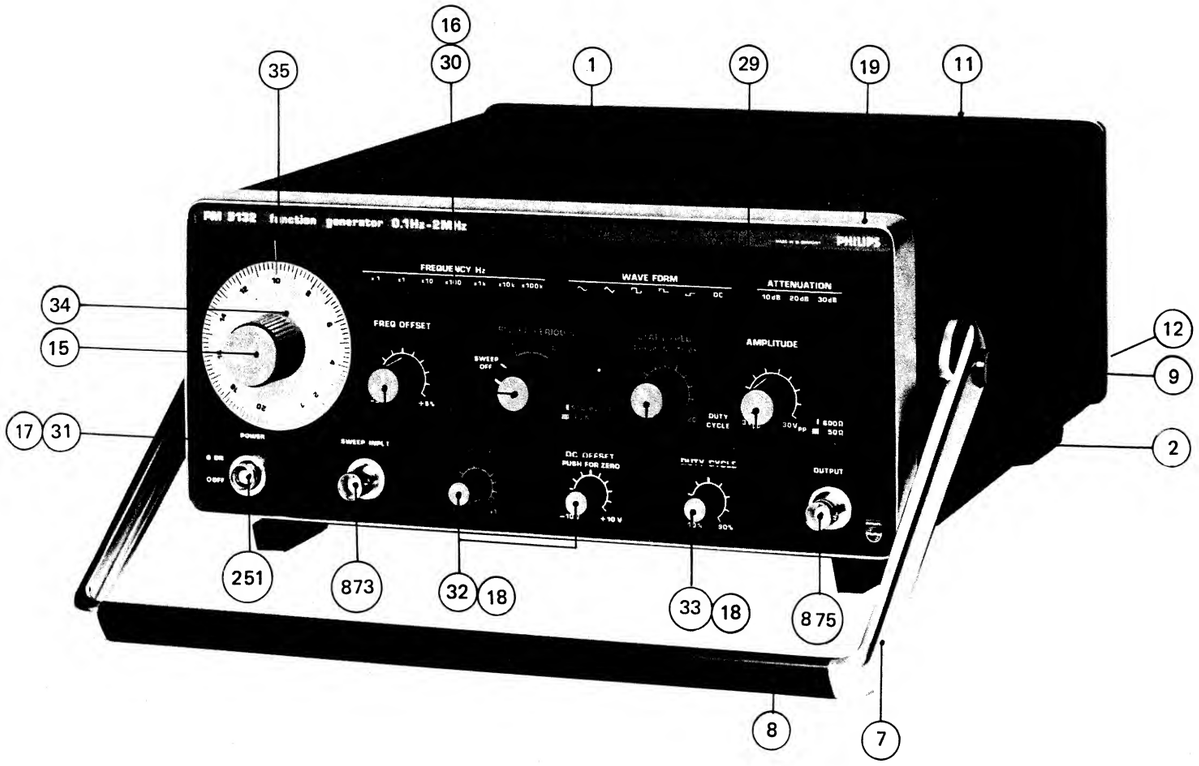


Fig.4. Unit 2, component lay-out



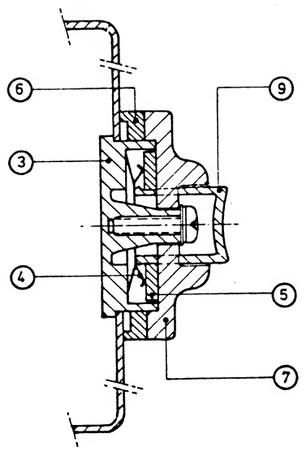


Fig.5. Front view, mechanical parts

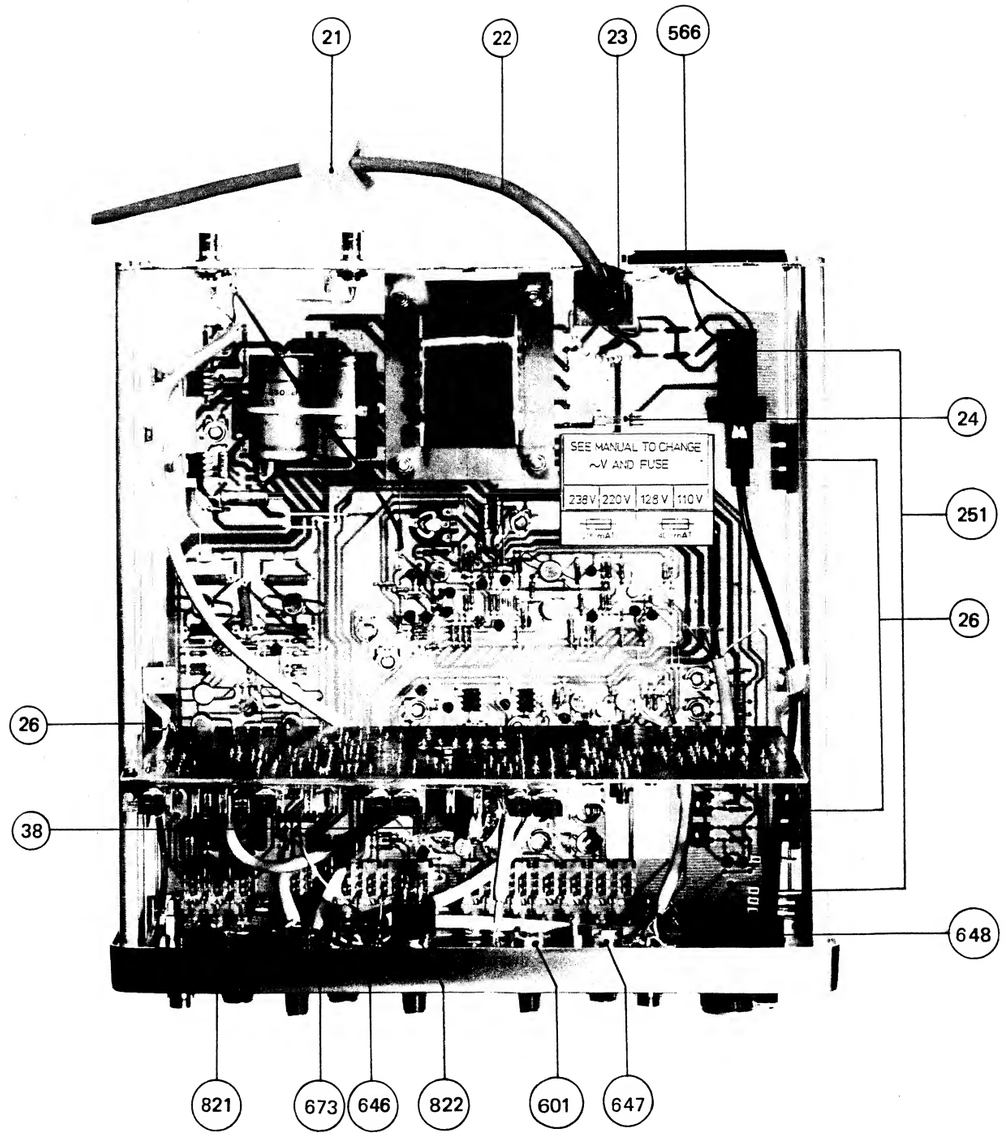


Fig.6. Bottom view

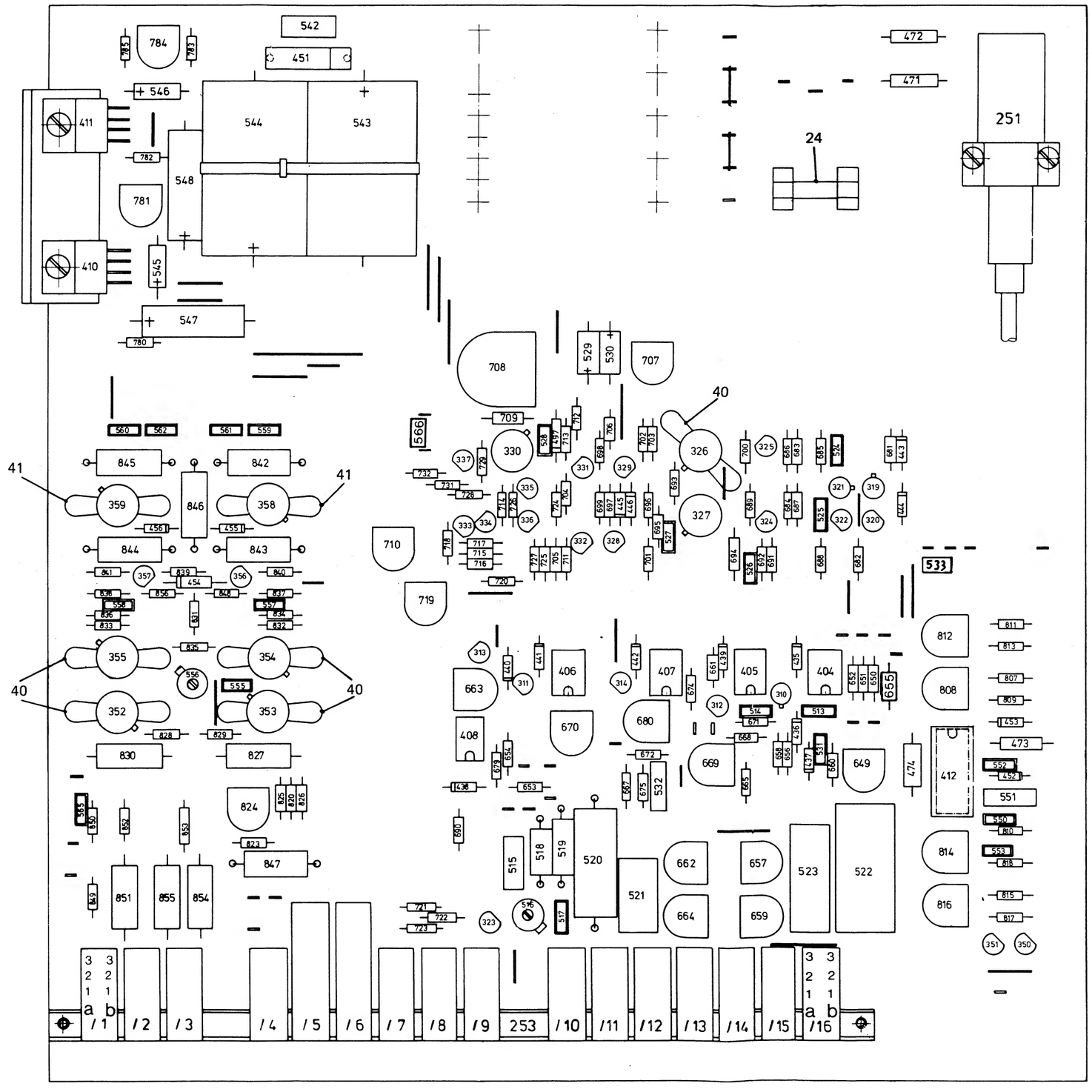


Fig.7. Unit 1, component lay-out

U2

sweep oscillator

controlled current source

U1

supply section

sine shaper

mains voltage

AMPLITUDE

DC OFFSET

ator

controlled current source

U1

U2

main oscillator

SWEEP OUT

SWEEP INPUT

START FREQ

FREQ

FREQ OFFSET

PEN LIFT

sine shaper

amplifier

attenuator

TTL OUT

OUTPUT

AMPLITUDE

DC OFFSET

*may be altered

section

Fig.8. Overall circuit-diagram PM5132